# IMAGE PICKUP APPARATUS INCLUDING LENS ELEMENTS HAVING DIFFERENT DIAMETERS

## CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation application of U.S. patent application Ser. No. 14/694,528, filed on Apr. 23, 2015, which claims priority from Korean Patent Application No. 10-2014-0048873, filed on Apr. 23, 2014, in the Korean Intellectual Property Office, the disclosures of which are incorporated herein by reference in their entireties.

## BACKGROUND

[0002] 1. Field

[0003] Apparatuses consistent with exemplary embodiments relate to an image pickup apparatus including lens elements having different diameters.

[0004] 2. Description of Related Art

[0005] Because thicknesses of mobile devices, such as mobile phones, are being continuously reduced, there is a demand to reduce thicknesses of optical systems of cameras disposed in mobile devices. When a thickness of an optical system is reduced, a focal length of the optical system is reduced, and thus a size of an image sensor is reduced. As a result, quality of an image picked up via the optical system may be deteriorated. The reason for the deterioration is that a number of pixels decreases as the size of an image is reduced. However, if a size of pixels of an image sensor is reduced in correspondence to the size reduction of the image sensor, images having sufficiently high resolutions may be obtained. Therefore, various attempts are being made to reduce pixel pitch of an image sensor. For example, a pixel pitch of current image sensors has been reduced to about 1 μm.

[0006] Meanwhile, because a thickness of a camera in a mobile device is limited, a unifocal lens with a short focal length is generally employed instead of a zoom lens with variable focal lengths. Therefore, it may be difficult for a camera of a mobile device to provide a zooming function. Most cameras in mobile devices provide a digital zooming function instead of an optical zooming function. In other words, because digital zoom is a function for magnifying a portion of an original image picked up by a camera merely via signal processing, quality of a magnified image may be deteriorated as an angle of view of the magnified image is narrowed.

## SUMMARY

[0007] Exemplary embodiments address at least the above problems and/or disadvantages and other disadvantages not described above. Also, the exemplary embodiments are not required to overcome the disadvantages described above, and an exemplary embodiment may not overcome any of the problems described above.

[0008] According to an aspect of an exemplary embodiment, there is provided an image pickup apparatus including lens elements, and image pickup regions respectively disposed in correspondence to the lens elements. At least two of the lens elements have different diameters, and at least two of the image pickup regions have different sizes. A smallest image pickup region among the image pickup regions having a smallest size among sizes of the image pickup regions is disposed with respect to a lens element among the lens elements having a largest diameter, and a largest image pickup region among the image pickup regions having a largest size among sizes of the image pickup regions is disposed with respect to a lens element among the lens elements having a smallest diameter.

[0009] The image pickup regions may include image sensors that are physically separated from each other.

[0010] At least two of the image pickup regions may have different pixel pitches, and a pixel pitch of an image pickup region among the image pickup regions may decrease as a diameter of a respective lens element among the lens elements increases.

[0011] The image pickup regions may be logically divided regions in a single image sensor.

[0012] The at least two of the lens elements may be configured to form light spots having different sizes on the respective image pickup regions.

[0013] The image pickup apparatus may be configured to extract depth information from images obtained via the lens elements and the respective image pickup regions.

[0014] The at least two of the lens elements may include a first lens element having a first diameter, a second lens element having a second diameter larger than the first diameter, and a third lens element having a third diameter larger than the second diameter. The at least two of the image pickup regions may include a first image pickup region corresponding to the first lens element and having a first size, a second image pickup region corresponding to the second lens element and having the first size, and a third image pickup region corresponding to the third lens element and having a second size smaller than the first size. The first image pickup region may have a first pixel pitch, a second image pickup region may have a second pixel pitch smaller than the first pixel pitch, and a third image pickup region may have a third pixel pitch smaller than the second pixel pitch.

[0015] The at least two of the lens elements may include a first lens element having a first diameter, a second lens element having the first diameter, and a third lens element having a second diameter larger than the first diameter. The at least two of the image pickup regions may include a first image pickup region corresponding to the first lens element and having a first size, a second image pickup region corresponding to the second lens element and having the first size, and a third image pickup region corresponding to the third lens element and having a second size smaller than the first size. The first and second image pickup regions may have a first pixel pitch, and a third image pickup region may have a second pixel pitch smaller than the first pixel pitch.

[0016] The first through third lens elements may be linearly disposed in a horizontal direction when viewed from a front or rear of the image pickup apparatus, the first lens element may be disposed between the second lens element and the third lens element, and the first image pickup region may be disposed between the second image pickup region and the third image pickup region.

[0017] The first through third lens elements may be linearly disposed in a horizontal direction when viewed from a front or rear of the image pickup apparatus, the third lens element may be disposed between the first lens element and the second lens element, and the third image pickup region may be disposed between the first image pickup region and the second image pickup region.